Many (all) the questions have been answered during the Q&A period. Nevertheless, we ask that you provide written answers below so students can come back to read them again. Thanks!

1. (Page 8) Vertical axis label says it is for M_WIMP = 50 GeV. How do the results change for other M_WIMP values?

The results depend on the choice of detector target. The best sensitivity with a LXe target is around 30-40 GeV, while for LAr it's a bit higher (100-150 GeV). We use a common benchmark of 50 GeV to compare among different targets.

2. (Page 24 and 25) It appears livetime fraction is low in these experiments. Page 24 shows 136 kg-day for 15-kg target, or ~10 days in 2006 - 2007. Page 25 shows 477 days in 2010 - 2014. What are the prospects of increasing livetime fraction?

This question has two parts: increasing livetime fraction as a function of total observing time, and increasing total exposure (kg-day). Here are some answers:

- The total operation time for a given experiment includes "WIMP search" time, but also calibrations, detector optimization, debugging of different components, etc. We try to be as efficient as possible in these non-WIMP phases of data collection, but at the same time we need to make sure that we achieve the best possible detector performance and the most accurate understanding of detector response (i.e. calibrations).
- Total exposure is dominated by the "fiducial volume" that can be used for WIMP search (the low-background, quiet region at the center of a detector). Strategies to maximize fiducial volume include: scaling up to larger targets (to exploit the stopping power of LAr/LXe); selecting lower radioactivity materials for photosensors and detector components; adding "active veto" detectors outside the central volume, to tag gamma and neutron events. This has improved over the years: the fiducial fraction in Xenon-10 was approximately 30%, while in LZ we are close to 80%.
- Finally, total exposure and livetime fraction are both determined by analysis prowess. It is not uncommon for Dark Matter experiments to increase both fiducial volume and livetime fraction during their observing time, as analyzers refine and improve their event selection cuts.

3. What is the future of WIMP experiments after they reach the neutrino haze level?

Direct detection is going to become more complicated, because we will not have a way to distinguish between WIMP events and coherent neutrino scattering. We should keep pushing detector sensitivity until we start observing the neutrinos, which will provide an “external calibration” for our detectors. Down the line, we will need to come up with some form of “directional detectors”, allowing us to distinguish between signals coming from the galaxy (WIMPs) and signals coming from the Sun or the Earth atmosphere (neutrinos). So far, the most advanced directional WIMP detector concepts are gaseous TPCs. The challenge with those detectors is that they require a very large volume for the same amount of mass, when compared to a liquid TPCs, which complicates underground installation dramatically. There are a few ideas for compact directional detectors, but they are still in the exploratory R&D phase.

4. In the Xenon detector, why do we need to have air in the top, what happened there?

At the top of the liquid Xenon we have a thin layer of Xenon gas, surrounded by electrodes which produce an intense electric field. This creates a proportional chamber, which multiplies the electrons produced in the ionization component of the scattering off a Xenon atom, allowing for a more precise measurement of the charge signal.

5. (Page 66) I don't understand how to go from different solar neutrino sources (Be7, B8, etc) to DM mass on the horizontal scale. Can you explain? Thank you!

We basically compute the recoil signal for each interaction (scattering from the WIMP or the neutrino) and put it on the same axis. For example, coherent scattering from Boron-8 solar neutrinos will produce a recoil spectrum that is similar to that from a ~6 GeV WIMP. Here is a recent paper on the topic: https://arxiv.org/abs/2109.03116

6. (page 31) I was wondering whether there is any way to minimize the inactive area in the array of PMTs, such as by making them closer together or adding an adjacent offset layer.

The array of PMTs is as densely packed as possible. Adding (for example) an offset array of PMTs would actually add shadows and make the problem worse. What we do instead to optimize light collection is to add PTFE (teflon) fillers in the gaps between the PMTs. PTFE has very high reflectivity in Liquid Xenon and adding PTFE spacers in the gaps has proven very effective at increasing light collection and therefore making the detector more sensitive. More details here: https://arxiv.org/abs/1910.09124